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BUREAU OF MINES

VAN. H. MANNING, DIRECTOR

PRODUCTION OF EXPLOSIVES IN THE UNITED STATES

DURING THE CALENDAR YEAR 1915

WITH NOTES ON COAL-MINE ACCIDENTS DUE TO EXPLOSIVES AND LIST OF PERMISSIBLE EXPLOSIVES, LAMPS, AND MOTORS TESTED PRIOR TO MAY 1, 1916

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COMPILED BY

ALBERT H. FAY

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PRODUCTION AND DISTRIBUTION OF EXPLOSIVES IN THE UNITED STATES DURING THE CALENDAR YEAR 1915, AND COAL-MINE ACCIDENTS DUE TO EXPLOSIVES.

Compiled by Albert H. Fay.

INTRODUCTION.

The total production of explosives, excluding exports, in the United States during the calendar year 1915, according to figures that the Bureau of Mines has received from manufacturers, was 460,900,796 pounds (230,450 short tons), as compared with 450,251,489 pounds (225,126 short tons) in 1914.

The production for 1915 is segregated as follows: Black powder, 197,722,300 pounds; "high" explosives other than permissible explosives, 235,828,587 pounds; and permissible explosives, 27,349,909 pounds. These figures represent a decrease of 8,377,400 pounds of black powder, and an increase of 17,374,616 pounds of high explosives and 1,652,091 pounds of permissible explosives, as compared with figures for 1914.

As explosives are essential to mining and the use of improved types of explosives tends to lessen the dangers attending this industry, the Bureau of Mines has undertaken the compilation of information showing the total amount of explosives manufactured and used in the United States, its first report, Technical Paper 69, dealing with the year 1912; the second, Technical Paper 85, with the year 1913; and the third, Technical Paper 107, with the year 1914. The report for 1915 is, therefore, the fourth paper of the series.

CLASSIFICATION OF EXPLOSIVES.

The production figures tabulated herein are classified as follows:

1. *Black blasting powder.*—All black powder with sodium or potassium nitrate as a constituent is here classified as black blasting powder.

2. *High explosives.*—Dynamite and all other high explosives of various trade names and compositions, except permissible explosives, are put in this class.

3. *Permissible explosives.*—In this class are included ammonium nitrate explosives, hydrated explosives, organic nitrate explosives,

and certain nitroglycerin explosives containing an excess of free water or carbon. All permissible explosives have passed certain tests of the Bureau of Mines, and are not to be regarded as permissible unless used in the manner specified by the bureau.[a]

ACKNOWLEDGMENTS.

The Bureau of Mines takes this opportunity to express its appreciation of the aid rendered by the manufacturers in furnishing the data compiled, and to Mr. C. Stewart Comeaux, acting secretary of the Institute of the Makers of Explosives.

SCOPE OF STATISTICS.

Table 1 shows, for the calendar years 1913, 1914, and 1915, the quantity of explosives used in those States wherein three or more manufacturers reported sales. States in which only one or two manufacturers reported sales are not segregated.

Tables 2, 3, and 4 give the total production and uses, by groups of States, of black powder, high explosives, and permissible explosives, respectively. The States are so grouped as to include regions where the general conditions of mining are more or less similar, and yet to avoid publishing sales of individual companies.

Table 5 shows the rapid increase in the production and sale of permissible explosives for use in coal mines. In 1902 only 11,300 pounds of permissible explosives were used in coal mining, whereas in 1915 the quantity so used was 21,841,659 pounds.

The quantity of permissible explosives used in the United States is larger than in a number of foreign countries. In 1912 it represented about 5 per cent of the total quantity of explosives produced, and in 1915, 5.9 per cent. The total amount of explosives used for the production of coal in 1915 was 196,739,634 pounds, of which about 11 per cent was of the permissible class, as compared with 8.9 per cent in 1914. There was a decrease of 9,298,700 pounds in the amount of black blasting powder used for coal mining.

Table 6 gives the quantities of permissible explosives used for coal mining in the various coal fields. The table shows that in 1915 about 78 per cent of the permissible explosives manufactured were used for coal mining. The remaining 22 per cent was reported under the items "Other mining" and "All other purposes," as indicated in Table 4. The figures for 1915 represent the reports of 32 manufacturers who operated their various plants during the year. In many cases the manufacturer operated more than one plant, so that the

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[a] Hall, Clarence, Snelling, W. O., and Howell, S. P., Investigations of explosives used in coal mines, with a chapter on the natural gas used at Pittsburgh, by G. A. Burrell, and an introduction by C. E. Munroe: Bull. 15, Bureau of Mines, 1912, 197 pp.

Hall, Clarence, and Howell, S. P., Tests of permissible explosives: Bull. 66, Bureau of Mines, 1913, 313 pp.

above number does not necessarily indicate the total number of plants. The number of manufacturers reporting sales of black powder was 24, of high explosives 23, and of permissible explosives 15. A number of other companies reported their plants as having been idle during the year, or as having been sold to other manufacturers.

The reports of manufacturers of fireworks and of ammunition are not included, inasmuch as the majority of these manufacturers purchase their explosives from one or more of the manufacturers of explosives whose production has been included in the tabulations presented herein.

MINE ACCIDENTS DUE TO EXPLOSIVES.

Table 7 shows the total number of coal-mine fatalities due to explosives from 1910 to 1915, inclusive. The number killed in the various States each year is erratic, and the number killed in any one district does not show any uniform increase or decline.

Table 8 shows the total number killed in the bituminous coal mines from 1903 to 1915, inclusive. It also shows that in 1903 9.8 per cent of all of the fatalities at bituminous coal mines were due to explosives, and that the fatality rate per 1,000 was 0.339. Both the percentage and the number killed per 1,000 employed show a gradual decline to date, with the exception of 1915, which is slightly higher than 1914. A large percentage of this decline may be attributed to the increased use of permissible explosives. The number killed by explosives in and about anthracite mines of Pennsylvania (Table 9) is practically one-half the total number killed by explosives in all coal mines. The fatality rate in the anthracite fields of Pennsylvania due to this cause has shown a slight decrease since 1911. The average number killed per 1,000 employed in the anthracite field from 1870 to and including 1913 was 0.354. The principal decrease in coal-mine fatalities due to explosives has been in the bituminous mines, where in 1914 and 1915 approximately three-fourths of the permissible explosives were used. The first records for permissible explosives in the anthracite field are given in the inspector's report for the year 1909. Prior to that date the total amount of permissibles used in the coal mines, as shown in Table 5, represents approximately the quantity used in the bituminous fields. Table 6 shows separately the amount used in the anthracite and bituminous mines since 1910.

Table 9 shows, for the periods indicated, that 3,675 men were killed in the coal mines since the beginning of inspection service in the various States to the close of 1913. The fatalities shown in this table are classified in 14 groups, from which it appears that nearly 18 per cent occurred during the handling and transportation of explosives, and approximately 25 per cent may be grouped as due to

premature blasts and short fuse. Comparatively few fatalities at coal mines are caused by thawing of explosives, and still fewer to unexploded charges in coal and débris. The total number of fatalities due to shots breaking through pillar or rib was 216, or nearly 6 per cent.

The fatalities caused by explosives at metal mines were 78 for 1911, 94 for 1912, 89 for 1913, and 60 for 1914. The fatalities at quarries for the same years were 50, 47, 44, and 35, respectively.

The use of permissible explosives in coal mining has unquestionably resulted in lessening risks, and few, if any, of the serious mine disasters can be attributed directly to their proper use.

PRODUCTION AND DISTRIBUTION OF EXPLOSIVES—COAL-MINE FATALITIES.

The production and use of explosives in the United States are given in detail in Tables 1 to 6 following. Statistics on fatalities in coal mines from their use are given in Tables 7, 8, and 9.

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TABLE 1.—*Amount of explosives (excluding exports) manufactured in the United*

State.	1913		
	Black blasting powder.	High explosives other than permissible.	Permissible explosives.
	Kegs.	*Pounds.*	*Pounds.*
Alabama	204,151	5,573,850	4,396,667
Alaska	(a)	3,571,470	.....
Arizona	30,550	8,731,335	.....
Arkansas	107,679	1,240,465	4,300
California	182,974	12,048,102	(a)
Colorado	82,542	7,760,290	684,687
Connecticut	2,994	710,518	(a)
Delaware	(a)	(a)	(a)
District of Columbia	(a)	(a)	.....
Florida	1,518	2,187,268	.....
Georgia	23,524	1,178,770	.....
Idaho	11,502	3,995,415	(a)
Illinois	1,294,282	6,689,690	1,578,925
Indiana	543,212	2,452,364	81,750
Iowa	310,206	1,921,721	(a)
Kansas	466,244	3,293,798	32,275
Kentucky	279,964	3,687,345	467,550
Louisiana	(a)	1,146,162	(a)
Maine	6,693	831,484	(a)
Maryland	37,966	1,475,214	(a)
Massachusetts	8,636	1,497,992	(a)
Michigan	25,148	21,818,795	(a)
Minnesota	(a)	11,105,635	.....
Mississippi	4,572	693,523	(a)
Missouri	172,866	15,712,677	(a)
Montana	109,969	8,751,955	(a)
Nebraska	4,713	263,450	(a)
Nevada	(a)	6,836,785	(a)
New Hampshire	644	172,550	.....
New Jersey	4,477	2,175,336	(a)
New Mexico	45,662	1,955,230	(a)
New York	38,802	12,519,410	(a)
North Carolina	32,480	1,670,475	10,000
North Dakota	11,578	287,600	(a)
Ohio	347,374	7,272,123	20,600
Oklahoma	182,927	2,134,864	354,800
Oregon	(a)	4,538,430	.....
Pennsylvania	2,843,343	36,532,915	9,836,050
Rhode Island	341	81,075	.....
South Carolina	(a)	483,030	.....
South Dakota	(a)	1,937,305	.....
Tennessee	263,035	4,575,107	226,337
Texas	69,105	1,681,600	(a)
Utah	136,098	5,721,925	3,963,700
Vermont	11,790	331,450	.....
Virginia	182,740	3,569,293	160,650
Washington	60,077	8,610,471	(a)
West Virginia	668,884	4,534,400	3,498,460
Wisconsin	5,528	5,876,207	(a)
Wyoming	105,824	461,735	258,650
Not segregated	274,967	87,940	2,110,369
Total	c 9,197,581 d 229,939,531	242,386,544	27,685,770
Grand total (pounds)	500,011,845		
Total, 1912	c 9,211,735 d 230,293,369	234,469,492	24,630,270
Grand total (pounds), 1912	489,493,131		

a Represents the product of only one or two manufacturers, and is included in item "Not segregated," at bottom of column.

States and used in the various States during the calendar years 1913, 1914, and 1915.

1914			1915		
Black blasting powder.	High explosives other than permissible.	Permissible explosives.	Black blasting powder.	High explosives other than permissible.	Permissible explosives.
Kegs.	*Pounds.*	*Pounds.*	*Kegs.*	*Pounds.*	*Pounds.*
178,689	3,921,685	3,171,697	188,607	4,271,724	2,730,164
(a)	(a)	.....	(a)	4,683,785	.....
9,346	7,986,113	(a)	7,339	8,845,785	(a)
88,363	1,137,869	(a)	77,834	1,206,345	33,900
110,418	10,344,833	(a)	78,942	13,377,140	(a)
82,472	7,165,230	812,550	74,831	8,324,900	701,925
1,888	751,265	(a)	(a)	726,878	(a)
(a)	(a)	.....	(a)	58,350	.....
.....	15,250	.....	(a)	(b)	.....
991	1,935,619	.....	(a)	1,434,122	(a)
16,706	785,471	(a)	15,383	775,025	(a)
6,566	3,676,450	.....	5,639	4,783,235	.....
1,205,636	6,260,121	1,344,375	1,151,309	6,981,538	1,584,775
508,226	2,619,206	90,623	487,052	2,717,123	153,100
346,910	1,846,192	27,650	381,116	1,817,306	(a)
503,688	3,105,531	(a)	484,989	2,843,152	16,712
302,772	2,258,712	550,600	242,056	1,430,739	663,115
(a)	822,974	(a)	(a)	1,146,825	(a)
3,907	755,895	.....	1,957	774,608	(a)
23,422	1,476,686	11,450	24,587	1,294,303	37,500
6,561	1,432,825	(a)	6,567	932,893	.....
34,371	20,812,133	(a)	20,793	26,984,039	(a)
140,834	9,072,006	(a)	125,713	9,785,271	(a)
2,213	745,630	.....	2,208	494,066	(a)
156,118	13,962,593	324,100	146,142	20,000,044	33,390
86,397	6,842,101	(a)	73,746	7,461,360	(a)
4,001	219,110	.....	3,297	228,665	.....
16,179	5,792,895	(a)	1,848	7,008,266	(a)
1,026	156,050	(a)	810	155,100	.....
6,347	2,187,358	(a)	3,824	2,597,123	300
58,516	1,874,677	(a)	36,458	2,299,450	(a)
31,313	10,050,483	(a)	30,313	9,952,161	362,300
11,270	1,952,940	(a)	20,882	1,804,987	.....
12,950	291,394	(a)	12,070	343,639	(a)
246,727	8,815,955	30,775	312,155	6,633,779	23,375
187,935	2,269,729	387,455	160,748	2,522,615	428,196
29,006	4,578,205	(a)	26,784	3,908,120	(a)
2,720,550	34,808,704	9,208,600	2,574,478	31,755,480	10,760,098
(a)	52,800	.....	398	84,632	.....
449	287,445	.....	4,063	311,535	.....
5,497	2,032,826	.....	3,424	1,986,468	.....
126,035	3,389,283	124,938	106,890	3,311,955	201,078
53,459	1,226,391	(a)	58,124	1,936,296	13,750
21,519	3,297,570	(a)	(a)	3,875,985	(a)
10,004	213,025	.....	12,231	251,068	.....
124,293	3,261,091	200,450	126,418	3,733,849	212,650
(a)	8,093,036	(a)	50,525	7,635,266	(a)
611,817	4,122,230	3,546,099	628,770	3,087,886	3,783,225
6,775	5,972,077	13,029	6,347	6,736,319	(a)
102,435	449,407	229,550	102,377	517,387	(a)
39,391	3,326,900	5,623,877	28,848	.....	5,610,356
c 8,243,988	218,453,971	25,697,818	c 7,908,892	235,828,587	27,349,909
d 206,099,700	.....	.....	d 197,722,300	.....	.....
	450,251,489			460,900,796	

b Included in figures for Maryland. c Kegs of 25 pounds each. d Pounds.

TABLE 2.—*Amount of* ***black blasting powder*** *used in the United States during 1914 and 1915, classified by use.*

[Kegs of 25 pounds each.]

Groups of States.	Black blasting powder, 1914.				Black blasting powder, 1915.			
	Coal mining.	Other mining.	Railway and other construction work.	All other purposes.	Coal mining.	Other mining.	Railway and other construction work.	All other purposes.
	Kegs.	*Kegs.*	*Kegs.*	*Kegs.*	*Kegs.*	*Kegs.*	*Kegs.*	*Kegs.*
Group 1. Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont	.....	12	521	21,262	.....	.....	40	21,923
Group 2. Connecticut, New Jersey, and New York	.....	2,900	2,311	34,337	.....	4,144	2,446	28,467
Group 3. Delaware, District of Columbia, Maryland, and Virginia	103,250	1,359	20,934	22,436	107,297	1,512	20,545	21,707
Pennsylvania	2,477,542	16,237	68,063	158,708	2,271,725	16,146	70,698	215,909
West Virginia	566,692	6,304	20,375	18,446	587,970	4,440	15,378	20,982
Group 4. Florida, Georgia, North Carolina, and South Carolina	5,400	3,178	8,201	12,637	3,615	3,753	26,208	8,606
Group 5. Indiana and Kentucky	764,368	5,665	7,640	33,325	667,355	4,572	7,058	50,123
Illinois	1,195,026	5	533	10,072	1,138,274	2,350	392	10,293
Ohio	192,097	33,376	2,390	18,864	253,343	25,157	8,166	25,489
Group 6. Alabama, Mississippi, and Tennessee	247,327	18,608	26,043	14,959	247,941	14,575	16,098	19,091
Group 7. Michigan, Minnesota, and Wisconsin	28,999	140,150	2,798	10,033	16,242	120,462	2,047	14,102
Group 8. Iowa, Kansas, Missouri, and Nebraska	941,702	8,654	16,934	43,427	931,951	18,516	12,889	52,188
Group 9. Arkansas, Louisiana, Oklahoma, and Texas	294,177	5,593	7,855	22,259	243,791	13,159	6,176	34,168
Group 10. Montana, North Dakota, South Dakota, and Wyoming	158,270	2,550	14,209	32,250	148,090	1,030	15,517	26,980
Group 11. Colorado, New Mexico, and Utah	84,541	37,065	13,502	27,399	66,422	29,638	12,137	25,137
Group 12. Alaska, Idaho, Oregon, and Washington	13,115	3	29,303	31,854	16,532	3,001	23,526	43,274
Group 13. Arizona, California, and Nevada	.....	21,226	74,519	40,198	10	5,691	50,548	31,880
Total (kegs)	7,072,506	302,885	316,131	552,466	6,700,558	268,146	289,869	650,319
Grand total (kegs)	8,243,988				7,908,869			

TABLE 3.—*Amount of* ***high explosives*** *used in the United States during 1914 and 1915, classified by use.*

Groups of States.	High explosives other than permissible explosives, 1914.				High explosives other than permissible explosives, 1915.			
	Coal mining.	Other mining.	Railway and other construction work.	All other purposes.	Coal mining.	Other mining.	Railway and other construction work.	All other purposes.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Group 1. Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont	.....	35,100	904,814	1,670,681	.....	26,150	392,397	1,779,754
Group 2. Connecticut, New Jersey, and New York	.....	2,647,617	3,798,340	6,543,149	.....	3,557,923	3,143,612	6,574,627
Group 3. Delaware, District of Columbia, Maryland, and Virginia	286,500	317,125	1,074,051	3,153,751	218,575	660,650	1,109,670	3,097,607
Pennsylvania	19,204,406	562,980	4,148,180	10,893,138	18,131,609	728,637	2,407,202	10,488,032
West Virginia	510,725	12,400	1,599,256	1,999,849	521,125	158,900	684,175	1,723,686
Group 4. Florida, Georgia, North Carolina, and South Carolina	2,800	409,235	1,244,755	3,304,685	4,800	555,550	1,222,160	2,543,159
Group 5. Indiana and Kentucky	208,734	31,425	869,129	3,768,630	159,107	30,500	399,310	3,558,945
Illinois	143,450	814,350	517,250	4,785,071	123,470	1,118,250	656,075	5,083,743
Ohio	547,700	325,750	217,900	7,724,605	567,131	248,650	717,875	5,100,123
Group 6. Alabama, Mississippi, and Tennessee	913,775	3,280,606	1,701,350	2,160,867	690,619	4,190,880	933,061	2,263,185
Group 7. Michigan, Minnesota, and Wisconsin	31,900	26,912,667	529,100	8,382,549	53,750	34,744,903	489,525	8,217,451
Group 8. Iowa, Kansas, Missouri, and Nebraska	1,076,450	11,645,412	829,395	5,582,169	1,049,139	17,392,547	1,070,978	5,376,503
Group 9. Arkansas, Louisiana, Oklahoma, and Texas	665,770	649,750	651,849	3,489,594	138,680	1,946,100	911,690	3,815,611
Group 10. Montana, North Dakota, South Dakota, and Wyoming	154,150	7,592,115	408,185	1,461,278	198,750	7,917,735	467,060	1,725,309
Group 11. Colorado, New Mexico, and Utah	243,760	6,381,865	500,105	5,211,747	277,360	7,615,810	441,165	6,166,000
Group 12. Alaska, Idaho, Oregon, and Washington	225,825	6,518,435	4,885,672	7,966,259	244,910	8,713,110	2,910,759	9,141,627
Group 13. Arizona, California, and Nevada	.....	16,127,745	4,104,615	3,891,481	5,000	19,522,671	4,322,985	5,380,535
Total (pounds)	24,215,945	84,264,577	27,983,946	81,989,503	22,384,025	109,128,966	22,279,699	82,035,897
Grand total (pounds)	218,453,971				235,828,587			

TABLE 4.—*Amount of* ***permissible explosives*** *used in the United States during 1914 and 1915, classified by use.*

Groups of States.	Permissible explosives, 1914.				Permissible explosives 1915.			
	Coal mining.	Other mining.	Railway and other construction work.	All other purposes.	Coal mining.	Other mining.	Railway and other construction work.	All other purposes.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Group 1. Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont				1,050		200		
Group 2. Connecticut, New Jersey, and New York		333,100	500	2,997		326,300	1,500	36,469
Group 3. Delaware, District of Columbia, Maryland, and Virginia	131,825	6,000		74,075	183,950	19,500	1,000	45,700
Pennsylvania	8,989,625		34,175	184,800	10,597,293	1,950	16,425	144,430
West Virginia	3,214,449	21,550		310,100	3,679,375	21,650	2,200	80,000
Group 4. Florida, Georgia, North Carolina, and South Carolina		900		4,430	600	1,850		4,915
Group 5. Indiana and Kentucky	564,525	20,800		55,898	722,990	16,600	300	76,325
Illinois	1,327,575	200		16,600	1,568,200			16,575
Ohio	11,200	3,225		16,350	11,750	5,500		6,125
Group 6. Alabama, Mississippi, and Tennessee	2,982,363	191,416	52,600	70,256	2,787,949	71,600	22,970	49,123
Group 7. Michigan, Minnesota, and Wisconsin		2,500		76,279		6,873		30,382
Group 8. Iowa, Kansas, Missouri, and Nebraska	15,237	279,750	25,050	45,150	16,737	14,500	600	19,915
Group 9. Arkansas, Louisiana, Oklahoma, and Texas	396,700	41,600	750	15,850	416,273	67,762	48,948	4,513
Group 10. Montana, North Dakota, South Dakota, and Wyoming	261,850	30,600		7,800	282,025	26,300	21,450	1,900
Group 11. Colorado, New Mexico, and Utah	1,534,900	3,817,200	68,700	89,550	1,428,967	4,032,150	24,450	159,125
Group 12. Alaska, Idaho, Oregon, and Washington	163,643	8,000		1,000	145,050	2,000		2,400
Group 13. Arizona, California, and Nevada		93,400	99,650	75	500	72,775		3,000
Total (pounds)	19,593,892	4,850,241	281,425	972,260	21,841,659	4,687,510	139,843	680,897
Grand total (pounds)	25,697,818				27,349,909			

TABLE 5.— *Yearly sales of short-flame explosives used in coal mines in the United States, 1901–1915.*

Year.	Quantity sold.	Year.	Quantity sold.
	Pounds.		*Pounds.*
1901		1909	8,942,857
1902	11,300	1910	11,820,836
1903	288,661	1911	13,428,239
1904	608,270	1912	18,150,618
1905	1,031,300	1913	21,804,285
1906	1,533,575	1914	19,593,892
1907	2,095,244	1915	21,841,659
1908	2,108,610		

TABLE 6.—*Quantity of permissible explosives used in different coal fields in the United States, 1910–1915.*

Coal fields and regions.	1910	1911	1912	1913	1914	1915
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
1. Pennsylvania anthracite field	1,486,100	1,917,412	2,177,172	3,294,225	4,380,635	5,037,050
2. Northern Appalachian region [a]	5,967,216	6,350,272	9,190,025	9,744,810	7,966,464	9,435,318
3. Southern Appalachian region	3,188,785	3,377,268	3,995,485	4,481,975	3,510,013	3,447,964
4. Eastern interior field	165,975	337,012	751,005	2,058,075	1,364,450	1,631,775
5. Western interior field	196,560	255,050	440,825	377,625	411,937	433,010
6. Rocky Mountain region	808,200	1,177,075	1,473,129	1,634,575	1,796,750	1,710,992
7. Pacific coast region	8,000	14,150	122,977	213,000	163,643	145,550
Total	11,820,836	13,428,239	18,150,618	21,804,285	19,593,892	21,841,659

[a] Not including Pennsylvania anthracite field.

TABLE 7.—*Coal-mine fatalities due to explosives, 1911–1915.*

States.	1911	1912	1913	1914	1915
Pennsylvania	94	85	79	97	88
West Virginia	3	8	8	5	6
Illinois	15	11	11	9	11
Ohio	3	5	6	2	3
Indiana, Michigan, and Kentucky	15	3	5	12	12
Alabama, Tennessee, Georgia, and North Carolina	6	6	2	2	10
Iowa, Kansas, and Missouri	4	14	6	4	13
Colorado, New Mexico, and Utah	3	1	7	4	.....
Maryland and Virginia	.....	10	2	.....	4
Montana, North Dakota, and Wyoming	4	2	4	4	3
Arkansas, Oklahoma, and Texas	11	1	5	4	5
Alaska, California, Idaho, Nevada, Oregon, and Washington	2	1	3	3	.....
Total	160	147	138	146	155

TABLE 8.—*Fatalities due to explosives at bituminous coal mines, 1903–1915.*

Year.	Number killed.	Percentage of total killed.	Number killed per 1,000 employed.
1903	138	9.80	.339
1904	121	8.64	.290
1905	119	7.49	.264
1906	115	7.27	.246
1907	134	5.29	.264
1908	109	6.17	.216
1909	122	5.88	.244
1910	113	5.09	.203
1911	72	3.68	.130
1912	70	3.85	.128
1913	63	2.91	.110
1914	56	3.01	.096
1915	76	3.36	.100

TABLE 9.—*Number of men killed by* ***explosives*** *in the coal mines (underground only) in the United States, by States,* ***during period shown ending Dec. 31, 1913,*** *for which continuous records are available.*[a]

State.	Period ending 1913, years.	Handling and transportation.	Handling caps, detonators, squibs, and fuse.	Thawing explosives.	Tamping.	Premature blast and short fuse.	Blown out or windy shot.	Flying pieces of rock or coal.	Returned too soon.	Delayed blast.	Shot breaking through pillar or rib.	Suffocation by powder gas.	Striking unexploded charge in removing débris.	Drilling into unexploded charge.	Unclassified.	**Total.**	Per centage of total killed in State.	Number killed per 1,000 employed.
Alabama	21	7	.....	.....	2	10	12	8	16	1	2	1	.....	.....	37	**96**	5.16	.27
Arkansas	9	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	15	**15**	14.01	.34
Colorado	28	2	2	.....	.....	19	3	5	2	2	1	6	.....	9	9	**60**	3.45	.25
Georgia	5	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	**1**	14.29	.43
Illinois	29	86	1	.....	10	94	81	47	52	3	32	7	.....	14	32	**459**	13.47	.34
Indiana	19	23	.....	.....	3	28	16	6	12	3	12	19	.....	2	8	**132**	19.44	.42
Iowa	26	9	1	.....	.....	18	4	25	3	.....	4	1	.....	2	7	**74**	10.25	.23
Kansas	21	11	9	.....	1	13	19	22	3	.....	3	29	.....	.....	21	**131**	24.81	.61
Kentucky	26	13	4	.....	.....	11	17	3	13	1	7	6	.....	4	10	**89**	14.02	.28
Maryland	23	2	1	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	.....	1	**5**	2.27	.04
Michigan	14	.....	1	.....	.....	6	.....	2	.....	1	1	1	.....	.....	3	**15**	15.31	.33
Missouri	26	3	.....	.....	.....	4	.....	8	8	2	5	8	.....	1	4	**43**	11.38	.20
Montana	14	2	.....	1	.....	.....	.....	1	1	.....	2	1	.....	.....	3	**11**	6.92	.27
New Mexico	21	.....	.....	.....	.....	4	5	5	1	3	1	1	.....	2	2	**24**	4.23	.48
North Dakota	6	.....	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	2	**3**	23.08	.72
Ohio	30	19	2	.....	.....	42	1	12	8	2	24	7	.....	.....	44	**161**	7.02	.17
Oklahoma	21	16	1	.....	.....	9	19	14	10	3	6	6	.....	.....	31	**115**	15.77	.86
Oregon	5	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	**0**	.....	.....
Pennsylvania (anthracite)	44	318	10	21	88	583	.....	420	126	9	77	10	3	26	99	**1,790**	10.10	.35
Pennsylvania(bituminous)	36	45	6	1	2	34	13	31	19	1	24	3	.....	3	3	**185**	1.95	.05
Tennessee	23	3	.....	.....	.....	2	5	2	4	.....	3	5	.....	.....	25	**49**	5.70	.25
Texas	5	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2	**2**	8.00	.09
Utah	22	1	.....	.....	.....	3	.....	1	.....	.....	.....	.....	.....	.....	.....	**5**	1.40	.13
Virginia	5	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	10	**10**	3.98	.25
Washington	25	2	2	2	.....	1	.....	.....	1	2	1	15	.....	3	3	**32**	5.00	.30
West Virginia	29	54	4	2	3	30	6	2	7	.....	10	1	.....	1	35	**155**	3.27	.16
Wyoming	6	1	.....	.....	.....	2	.....	.....	6	.....	1	.....	.....	2	1	**13**	5.40	.28
Total	.....	**617**	**44**	**27**	**109**	**914**	**201**	**614**	**293**	**33**	**216**	**127**	**3**	**69**	**408**	**3,675**	**7.59**	**.25**
Percentage of total	.....	16.79	1.20	.73	2.97	24.87	5.47	16.71	7.97	.90	5.88	3.45	.08	1.88	11.10	**100.00**	.....	.....

[a] Compiled from the annual reports of the State mine inspectors.

APPROVED PERMISSIBLE EXPLOSIVES, LAMPS, AND MINING EQUIPMENT.

In the bureau's educational campaign for safety at mines and the reduction of mine accidents it has been found advisable to introduce into the coal mines explosives and equipment that have passed certain specified tests conducted by the bureau's engineers.

The bureau has published the tests and requirements that explosives must pass in order to be considered as permissible for use in gaseous and dusty mines in Schedule 1,[a] Bulletin 66,[b] and Bulletin 96.[c] The list of explosives that have been approved by the bureau prior to July 1, 1915, is given in Technical Paper 100.[d]

Schedule 7[e] outlines tests that safety lamps must pass in order to be approved for use in all gaseous mixtures; Schedule 2A,[f] tests of electrical equipment, such as motors and coal-cutting machines for use in gaseous mines; and Schedule 6A,[g] tests of portable electric lamps.

The various schedules named above, stating the conditions and requirements under which these permissible devices are tested, may be obtained by application to the Director, Bureau of Mines, Washington, D. C.

The following equipment, including explosives, has passed the tests as above named and been placed on the permissible list:

PERMISSIBLE LIST MAY 1, 1916.

PERMISSIBLE MINERS' (FLAME) SAFETY LAMPS.

In accordance with the tests outlined in Schedule 7,[h] the bureau has approved as permissible for use in gaseous and dusty coal mines the following safety lamps:

Koehler miner's safety lamp, manufactured by the Koehler Manufacturing Co., Marlboro, Mass.

The Koehler lamp is made of steel, has a bonnet, and is equipped with a Pyro internal igniter and a Macbeth glass globe.

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[a] Fees for testing explosives and conditions and requirements under which explosives are tested: Schedule 1, Bureau of Mines, 1913, 8 pp.

[b] Hall, Clarence, and Howell, S. P., Tests of permissible explosives: Bull. 66, Bureau of Mines, 1913, 313 pp.

[c] Storm, C. G., Analysis of permissible explosives: Bull. 96, Bureau of Mines, 1916, 88 pp.

[d] Howell, S. P., Permissible explosives tested prior to Mar. 1, 1915: Tech. Paper 100, Bureau of Mines, 1915, 16 pp.

[e] Procedure for establishing a list of permissible miners' safety lamps; character of tests, conditions under which lamps will be tested, and fees: Schedule 7, Bureau of Mines, 1915, 10 pp.

[f] Procedure for establishing a list of permissible explosion-proof electric motors for mines; fees, character of tests, and conditions under which motors will be tested: Schedule 2A, Bureau of Mines, 1915, 11 pp.

[g] Procedure for establishing a list of permissible portable electric mine lamps; fees, character of tests, and conditions under which lamps will be tested: Schedule 6A, Bureau of Mines, 1915, 13 pp.

[h] Schedule 7, loc. cit.

PERMISSIBLE PORTABLE ELECTRIC MINE LAMPS.

Approval No. 10 covers a permissible portable electric mine lamp manufactured by the Edison Storage Battery Co., Orange, N. J. The only bulbs approved for use with this lamp are the symbol 26–V bulbs manufactured by the Independent Lamp & Wire Co., 1733 Broadway, New York, N. Y.; the symbol BM–10 bulbs manufactured by the National Lamp Works of the General Electric Co., Cleveland, Ohio, and the symbol BM–10 bulbs manufactured by the Edison Works of the General Electric Co., Harrison, N. J.

Approval No. 11 covers a permissible portable electric mine lamp manufactured by the Mannesman Light Co. of America, 331 Fourth Avenue, New York, N. Y. The only bulbs approved for use with these lamps are the symbol C–5 bulbs sold by the Mannesman Light Co. of America.

Approval No. 12 covers the Concordia permissible portable electric mine lamp manufactured by the Concordia Safety Lamp Co., Manufacturers' Building, Pittsburgh, Pa. The only bulbs approved for use with these lamps are the symbol Osram 08510 bulbs sold by the Concordia Safety Lamp Co.

EXPLOSION-PROOF COAL-CUTTING EQUIPMENT.

In accordance with Schedule 2A, the following coal-cutting equipment has the bureau's approval:

Approval No. 100, covering a 250-volt direct-current explosion-proof coal-cutting equipment manufactured by the Sullivan Machinery Co., Claremont, N. H.

Approval No. 100A, covering a 500-volt direct-current explosion-proof coal-cutting equipment manufactured by the Sullivan Machinery Co., Claremont, N. H.

PERMISSIBLE EXPLOSIVES TESTED PRIOR TO MAY 1, 1916.

By S. P. Howell.

The following table contains the brand name, class designation, grade of detonator or electric detonator prescribed, unit deflective charge, rate of detonation, and the name of the manufacturer of each of the 137 permissible explosives that have been tested by the Bureau of Mines prior to May 1, 1916.

All of these explosives are subject to the conditions and provisions detailed in Technical Paper 100.[a]

[a] Howell, S. P., Permissible explosives tested prior to Mar. 1 (with supplementary list to July 1), 1915; Tech. Paper 100, Bureau of Mines, 1915, 16 pp.

Permissible explosives tested prior to May 1, 1916.

Brand.	Class designation.	When used with detonators, preferably electric detonators of not less efficiency than—	Unit deflective charge.	Rate of detonation in 1¼ by 8 inch cartridge.		Manufacturer.
			Grams.	*Feet per second.*	*Meters per second.*	
Aetna coal powder A	Class 4	No. 6	277	12,620	3,848	Aetna Explosives Co. (Inc.), New York, N. Y.
Aetna coal powder AA	Class 1*a*	do	241	7,880	2,403	Do.
Aetna coal powder B	Class 4	do	301	9,870	3,008	Do.
Aetna coal powder C	do	do	344	7,010	2,138	Do.
Aetna coal powder No. 2	Class 1*a*	do	212	9,280	2,830	Do.
Bental coal powder No. 1–A	do	do	278	7,690	2,343	Hercules Powder Co., Wilmington, Del.
Bental coal powder No. 2	do	No. 7	276	4,750	1,447	Do.
Bental coal powder No. 2–X	do	No. 6	280	7,980	2,432	Do.
Bituminite No. 1[1]	Class 4	do	318	12,800	3,901	Aetna Explosives Co. (Inc.), New York, N. Y.
Bituminite No. 3[1]	do	do	294	9,330	2,843	Do.
Bituminite No. 4[1]	do	do	301	7,540	2,298	Do.
Bituminite No. 5[1]	Class 1*a*	do	231	9,120	2,782	Do.
Bituminite No. 8–L. F.[1]	Class 4	do	303	9,300	2,834	Do.
Black Diamond No. 2–A	do	do	281	12,600	3,842	Illinois Powder Manufacturing Co., St. Louis, Mo.
Black Diamond No. 3–A	do	do	294	11,160	3,402	Do.
Black Diamond No. 5	Class 1*a*	do	288	6,020	1,835	Do.
Black Diamond No. 6–L. F	Class 4	do	306	9,630	2,935	Do.
Black Diamond No. 7	Class 1*a*	do	214	10,730	3,270	Do.
Black Diamond No. 8	Class 4	do	295	8,730	2,663	Do.
Cameron mine powder No. 1–A	Class 1*a*	do	227	10,350	3,339	Cameron Powder Manufacturing Co., Emporium, Pa.
Cameron mine powder No. 2–A	do	do	230	[2] 10,520	3,206	Do.
Cameron mine powder No. 2–A, L. F	do	do	233	10,950	3,338	Do.
Cameron mine powder No. 3–A	Class 4	do	296	10,930	3,333	Do.
Cameron mine powder No. 5–A	do	do	299	8,900	2,712	Do.
Carbonite No. 1	do	do	259	10,950	3,338	E. I. du Pont de Nemours & Co., Wilmington, Del.
Carbonite No. 2	do	do	302	11,380	3,470	Do.
Carbonite No. 2–L. F	do	do	305	7,830	2,387	Do.
Carbonite No. 3	do	do	325	8,710	2,656	Do.
Carbonite No. 4	do	do	327	7,670	2,339	Do.

[1] Manufacture by Aetna Explosives Co. (Inc.), authorized under date of July 20, 1915.

[2] 1½-inch cartridges used.

Permissible explosives tested prior to May 1, 1916—Continued.

Brand.	Class designation.	When used with detonators, preferably electric detonators of not less efficiency than—	Unit deflective charge.	Rate of detonation in 1¼ by 8 inch cartridge.		Manufacturer.
			Grams.	*Feet per second.*	*Meters per second.*	
Carbonite No. 5	Class 4	No. 6	304	10,140	3,092	E. I. du Pont de Nemours & Co., Wilmington, Del.
Carbonite No. 6	do	do	345	7,490	2,285	Do.
Coalite X	Class 1*a*	do	226	9,000	2,745	Atlas Powder Co., Wilmington, Del.
Coalite No. 1	Class 4	do	296	7,930	2,418	Do.
Coalite No. 2-D	do	do	310	8,430	2,571	Do.
Coalite No. 2-D. L	do	do	271	7,340	2,237	Do.
Coalite No. 2-M, L. F	do	do	301	9,220	2,811	Do.
Coalite No. 3-X	Class 1*a*	do	274	7,290	2,223	Do.
Coalite No. 3-XC	do	do	250	8,320	2,536	Do.
Coal special No. 1	Class 4	do	288	11,800	3,598	Aetna Explosives Co. (Inc.), New York, N. Y.
Coal special No. 1-A	do	do	276	9,370	2,857	Do.
Coal special No. 1-L. F	do	do	277	8,280	2,524	Do.
Coal special No. 2	do	do	304	10,240	3,123	Do.
Coal special No. 2-W	do	do	277	11,590	3,534	Do.
Coal special No. 3-C	do	do	288	9,760	2,977	Do.
Collier powder B, N. F	Class 1*a*	do	224	10,950	3,338	Do.
Collier powder KN	do	do	222	11,610	3,539	Do.
Collier powder No. X	do	do	273	7,820	2,384	Do.
Collier powder X, L. F	do	do	252	9,990	3,047	Do.
Collier powder No. 2	Class 4	do	300	8,870	2,704	Do.
Collier powder No. 5	Class 1*a*	do	240	8,280	2,524	Do.
Collier powder No. 5-L. F	do	do	232	9,370	2,858	Do.
Collier powder No. 5, special	do	do	236	8,330	2,541	Do.
Collier powder No. 6-L. F	Class 4	do	317	9,660	2,944	Do.
Collier No. 9	Class 1*a*	do	283	6,690	2,040	Do.
Collier powder No. 11	do	do	217	11,680	3,561	Do.
Collier powder No. 11-L. F	do	do	226	10,850	3,307	Do.
Cronite No. 1	do	do	233	10,490	3,198	G. R. McAbee Powder & Oil Co., Pittsburgh, Pa.
Cronite No. 5	do	No. 7	249	8,090	2,466	Do.
Detonite special	do	do	312	[1] 10,840	3,305	The King Powder Co., Cincinnati, Ohio.
du Pont Lump Coal Powder No. 1	Class 4	No. 6	382	5,200	1,586	E. I. du Pont de Nemours & Co., Wilmington, Del.
du Pont Permissible No. 1	Class 1*a*	do	278	9,610	2,930	Do.

Eureka No. 2	Class 2	do	311	10,720	3,269	G. R. McAbee Powder & Oil Co., Pittsburgh, Pa.
Fort Pitt mine powder No. 1	Class 4	do	293	11,230	3,424	Fort Pitt Powder Co., Pittsburgh, Pa.
Fuel-ite No. 1	do	do	288	11,150	3,400	Burton Powder Co., Pittsburgh, Pa.
Fuel-ite No. 2	do	do	289	8,240	2,512	Do.
Fuel-ite No. 3	Class 1a	do	215	8,590	2,620	Do.
Giant coal-mine powder No. 5	do	do	228	10,230	3,118	Giant Powder Co. (Con.), Giant, Cal.
Giant coal-mine powder No. 6	Class 2	do	277	11,550	3,520	Do.
Giant coal-mine powder No. 7	do	do	245	10,830	3,301	Do.
Giant coal-mine powder No. 8	do	do	247	10,830	3,301	Do.
Guardian A	Class 4	No. 7	296	10,130	3,089	Hercules Powder Co., Wilmington, Del.
Guardian No. 2	Class 1a	No. 6	245	8,980	2,738	Do.
Guardian No. 2-X	do	do	245	7,990	2,437	Do.
Guardian No. 3	do	do	272	7,660	2,336	Do.
Guardian No. 3-X	do	do	252	8,470	2,582	Do.
Guardian coal powder B	Class 4	No. 7	310	8,960	2,733	Do.
Hecla No. 2	Class 1a	do	253	13,990	4,264	E. I. du Pont de Nemours & Co., Wilmington, Del.
Hygrade coal powder No. 2	Class 4	No. 6	329	8,450	2,576	Hygrade Powder Co., Philadelphia, Pa.
Kanite A	Class 1b	No. 8	255	[1] 10,730	3,270	W. H. Blumenstein Chemical Works, Pottsville, Pa.
Lomite No. 1	Class 2	No. 6	300	13,940	4,250	G. R. McAbee Powder & Oil Co., Pittsburgh, Pa.
Lowinite No. 2-B	Class 1a	do	258	9,740	2,971	Lowinite Explosives Manufacturing Co., Pittsburgh, Pa.
Meteor AXXO	Class 2	do	434	8,410	2,563	E. I. du Pont de Nemours & Co., Wilmington, Del.
Mine-ite A	Class 4	do	296	11,290	3,443	Burton Powder Co., Pittsburgh, Pa.
Mine-ite A-2	do	do	319	10,670	3,252	Do.
Mine-ite B	do	do	340	9,540	2,908	Do.
Mine-ite B-2	do	do	334	7,410	2,260	Do.
Mine-ite No. 5-D	Class 1a	do	241	8,720	2,658	Do.
Mine-ite No. 6-D	do	do	224	8,090	2,467	Do.
Miners Friend No. 1	do	do	233	11,580	3,529	Atlas Powder Co., Wilmington, Del.
Miners Friend No. 2	do	do	260	10,330	3,149	Do.
Miners Friend No. 3	do	do	252	8,030	2,449	Do.
Miners Friend No. 4	do	do	261	9,980	3,044	Do.
Miners Friend No. 5	do	do	250	8,570	2,614	Do.
Miners Friend No. 6	do	do	234	10,900	3,324	Do.
Monobel No. 1	do	do	216	11,700	3,568	E. I. du Pont de Nemours & Co., Wilmington, Del.
Monobel No. 2	do	do	239	9,870	3,009	Do.
Monobel No. 3	do	do	243	7,260	2,212	Do.
Monobel No. 4	do	do	248	8,980	2,738	Do.
Monobel No. 5	do	do	267	6,760	2,061	Do.
Monobel No. 6	do	do	218	10,380	3,165	Do.
Monobel No. 7	do	do	211	10,050	3,065	Do.
Nitro low-flame No. 1	Class 4	do	303	13,380	4,079	Nitro Powder Co., Kingston, N. Y.
Nitro low-flame No. 2	do	do	298	14,560	4,439	Do.

[1] 1¾-inch cartridges used.

Permissible explosives tested prior to May 1, 1916—Continued.

Brand.	Class designation.	When used with detonators, preferably electric detonators of not less efficiency than—	Unit deflective charge.	Rate of detonation in 1¼ by 8 inch cartridge.		Manufacturer.
			Grams.	*Feet per second.*	*Meters per second.*	
Red H No. 1	Class 1*a*	No. 6	216	11,700	3,568	Hercules Powder Co., Wilmington, Del.
Red H No. 2	do	do	239	9,870	3,009	Do.
Red H No. 3	do	do	243	7,260	2,212	Do.
Red H No. 4	do	do	248	8,980	2,738	Do.
Red H No. 5	do	do	267	6,760	2,061	Do.
Red H No. 6	do	do	218	10,380	3,165	Do.
Red H No. 7	do	do	211	10,050	3,065	Do.
Red H No. 8	do	do	278	7,590	2,315	Do.
Trojan coal powder H	Class 3	do	394	9,420	2,872	Pennsylvania Trojan Powder Co., Allentown, Pa.
Trojan coal powder I	do	do	410	9,620	2,934	Do.
Trojan coal powder J	do	do	360	10,590	3,230	Do.
Tunnelite AA	Class 1*a*	do	253	7,690	2,346	G. R. McAbee Powder & Oil Co., Pittsburgh, Pa.
Tunnelite B	do	do	249	9,990	3,047	Do.
Tunnelite C	do	do	255	10,060	3,068	Do.
Tunnelite No. 3	Class 4	do	291	10,110	3,083	Do.
Tunnelite No. 4	do	do	309	10,620	3,238	Do.
Tunnelite No. 5	do	do	328	8,400	2,562	Do.
Tunnelite No. 6	do	do	305	9,670	2,947	Do.
Tunnelite No. 6-L. F	do	do	301	9,620	2,933	Do.
Tunnelite No. 7	do	do	311	8,720	2,659	Do.
Tunnelite No. 8	do	do	324	8,020	2,446	Do.
Tunnelite No. 8-L. F	do	do	322	8,720	2,658	Do.
Vigorite No. 1	do	do	259	10,950	3,338	Atlas Powder Co., Wilmington, Del.
Vigorite No. 2	do	do	298	10,920	3,330	Do.
Vigorite No. 3	do	do	320	8,140	2,483	Do.
Vigorite No. 4	do	do	341	7,480	2,281	Do.
Vigorite No. 5	do	do	308	10,830	3,303	Do.
Vigorite No. 6	do	do	345	7,490	2,285	Do.
Xpdite No. 1	do	do	259	10,950	3,338	Hercules Powder Co., Wilmington, Del.
Xpdite No. 2	do	do	302	11,380	3,470	Do.
Xpdite No. 3	do	do	325	8,710	2,656	Do.
Xpdite No. 4	do	do	327	7,670	2,339	Do.
Xpdite No. 5	do	do	304	10,140	3,092	Do.
Xpdite No. 6	do	do	345	7,490	2,285	Do.

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BULLETIN 17. A primer on explosives for coal miners, by C. E. Munroe and Clarence Hall. 61 pp., 10 pls., 12 figs. Reprint of United States Geological Survey Bulletin 423.

BULLETIN 48. The selection of explosives used in engineering and mining operations, by Clarence Hall and S. P. Howell. 1913. 50 pp., 3 pls., 7 figs.

BULLETIN 51. The analysis of black powder and dynamite, by W. O. Snelling and C. G. Storm. 1913. 80 pp., 5 pls., 5 figs.

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TECHNICAL PAPER 6. The rate of burning of fuse as influenced by temperature and pressure, by W. O. Snelling and W. C. Cope. 1912. 28 pp.

TECHNICAL PAPER 7. Investigations of fuse and miners' squibs, by Clarence Hall and S. P. Howell. 1912. 19 pp.

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